

Standardization methodologies: a dosimetry exercise for the NIAID-RERF project

**TM Seed
Tech Micro Services**

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Introduction

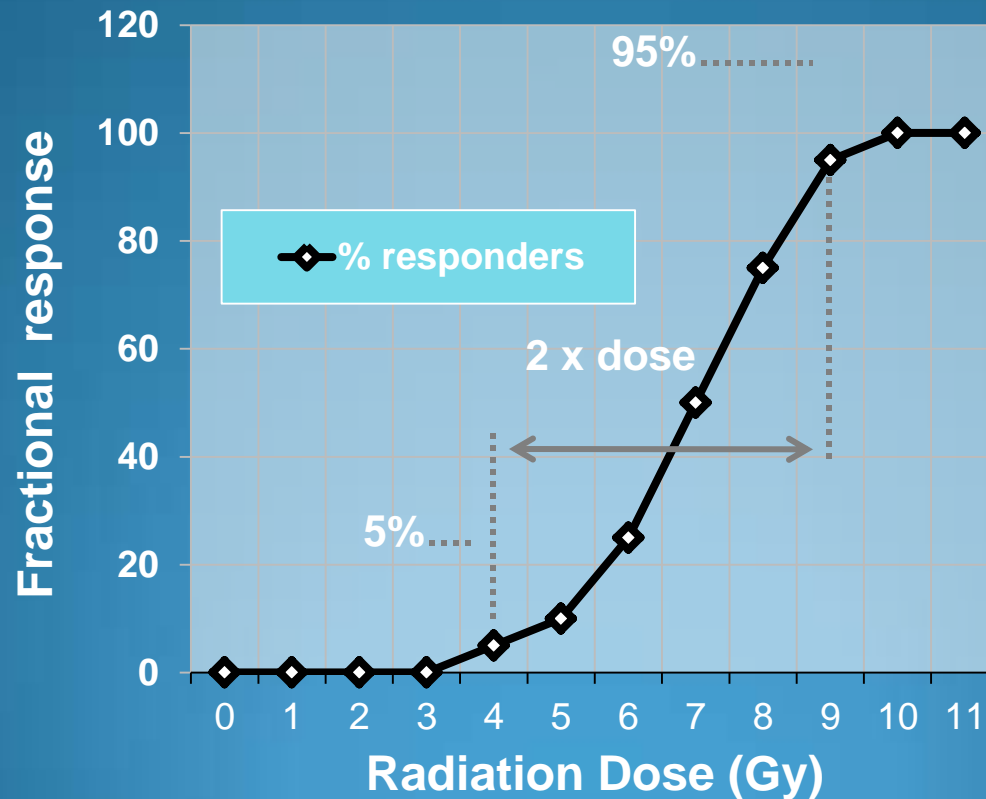
- ✓ Multi-institutional NIAID-sponsored research project entitled “Studies of immunosenescence and other late effects of acute ionizing radiation exposures in atomic bomb survivors” initiated October 2009 and continues to date.
- ✓ Supplemental, supporting experimental radiation studies using small animal (mice) models are being conducted by a number of the collaborating researchers.
- ✓ Need to verify the accuracy of the radiation doses being delivered to experimental animals under test.
- ✓ Accuracy and reproducibility of such exposures are fundamental to the proper performance of radiobiologic investigations.

Goals

- ✓ ***Elevate awareness*** of the project's investigators of the ***dosimetric requirement*** for quality radiobiologic investigation.
- ✓ ***Assuring radiation doses*** being delivered to experimental animals ***are consistent, with a minimal accuracy of 95%*** or better (or conversely, a maximum error of 5% or less)

Why the need of a dosimetry exercise?

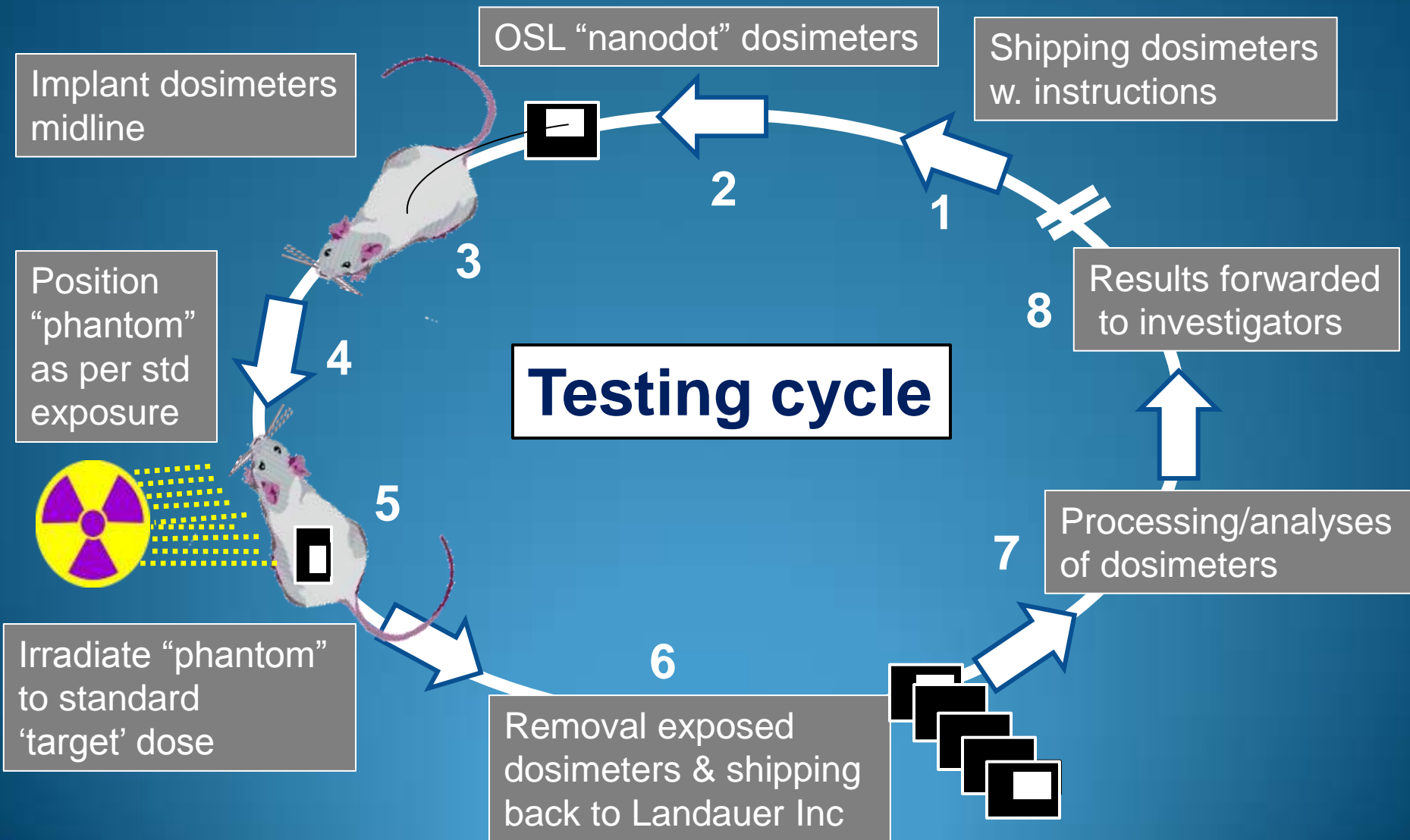
At ~ED50 doses dose-response curves are steeply sloped



Basic approach

- ✓ Use of *realistic phantoms* (freshly sacrificed mouse carcass) w. *midline embedded* mini optical stimulated luminescence (OSL) *nanodot dosimeters*
- ✓ Phantoms w. embedded dosimeters irradiated to set number of specific doses under simulated experimental conditions.
- ✓ Exposed dosimeters removed and shipped to Landauer Inc (Glenwood, IL) for 'reading' of doses.
- ✓ Exposure data sent back to investigators for review and analyses, and for possible adjustments to the exposure protocol.

Approach



Basic approach (con't)

- ✓ **Two guidance documents** developed to assist investigators in this dosimetry exercise:
 - i) **Basic Instructions for using the 'Inlight nanoDot' radiation dosimeters**
 - ii) **Standard Operating Procedures (generic) for Experimental Radiation Exposures**

- ✓ **Survey of IR exposure devices**, exposure protocols, and laboratory-specific capabilities

Specification data sheet- OSL nanoDot dosimeters

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SPECIAL SERVICES

InLight® nanoDot™

Change in Service—from TLD to InLight nanoDot

The simplest, the newest innovation for single point radiation measurement, is now available through Landauer Special Services. The nanoDot uses Optically Stimulated Luminescence (OSL) Technology—the same technology as used in Lux® and InLight dosimeters. The nanoDot can be used for diagnostic radiology, therapy, or any single point radiation assessment application, and is currently being used for a variety of applications throughout the world.

Special Services is now using nanoDot dosimeter® as dosimeter type X for all Special Services applications, and has discontinued the use of TLD dosimeter®. Special Services now offers the following options:

Reader Calibration Options

4 Standard – Choose either an 80 kVp (2.0mm Al FWH) or photon calibration, or a Co-127 in air calibration. The phantom is a 30 cm x 30 cm x 10 cm PMMA whole body phantom. Calibration dose is H_{0.07} or entrance skin dose for 80 kVp, and Dmax/Co-127.

4 Non-Standard – Additional calibration standards are available for an additional charge.

Category	Radiation Environment	Conditions
Diagnosis	Photon Standard Calibration	80 kVp, 2.0mm Al FWH
	CT	120 kVp, 8.0mm Al FWH
	Mammography	28 kVp, 0.28mm Al FWH
	Dental	70 kVp, 2.0mm Al FWH
	Co-127 X-ray Phantom	With buildup, In-air
Therapy	Co-127 X-ray Phantom	Without buildup, Entrance and dose relative to Co-127
	15-15 Head Electrons	
	Co-60	
	Co-60	
Institute 1	Co-60	80 kVp, 2.0mm Al FWH
	Co-60	120 kVp, 8.0mm Al FWH
	Co-127 (Standard Calibration)	Not applicable (Co-60)

* Institute Category may be reported as that shown upon request.

4 Custom – Custom calibration sets for a radiation environment not identified above can be built by a customer using screened nanoDots (see below) purchased as part of this service.

- Single-Point Set – A total of 10 screened dosimeters, 3 exposed by the customer to a known dose, and 3 blanks. Landauer's laboratory microStar® reader will be calibrated to this single point, and the dose will be calculated using this reference.
- Four-Point Set – A total of 10 screened dosimeters, 12 exposed by the customer to a range of known doses, and 3 blanks. The low and high dose settings of Landauer's laboratory microStar reader will be calibrated using these four points. Dose levels are determined after consultation with Special Services and a Subject Matter Expert (Health or Medical Physicist) at Landauer.

Custom calibration dosimeters are obtained by Special Services for up to 6 months or 10 uses, whichever comes first. During this retention period, custom calibrations are used in place of the standard calibrations.

Screened nanoDots

Similar to TLDs, the nanoDot dosimeter uses a "batch" sensitivity to calculate the dose from its response. Dosimeter screening provides a report booklet separately at no charge that details the reproducibility of the dosimeter and identifies which dosimeters have a higher range of measurement accuracy.

- General Population – Measurement accuracy is ±4-6.0% (1-σ)
- Research – Measurement accuracy is ±1-3.0% (1-σ)

Special Services Dosimetry Service Rates – nanoDot

Service includes processing and reporting of results via desktop or e-mail. Custom packaging available at an additional cost. Prices include shipping and handling.

Material	Calibration			Reference Point	
	Standard	Non-Standard	Custom	Single	Batch
Standard	\$18.95	\$31.95	---	\$100	\$400
Non-Standard	\$24.95	\$36.95	\$25.00*		

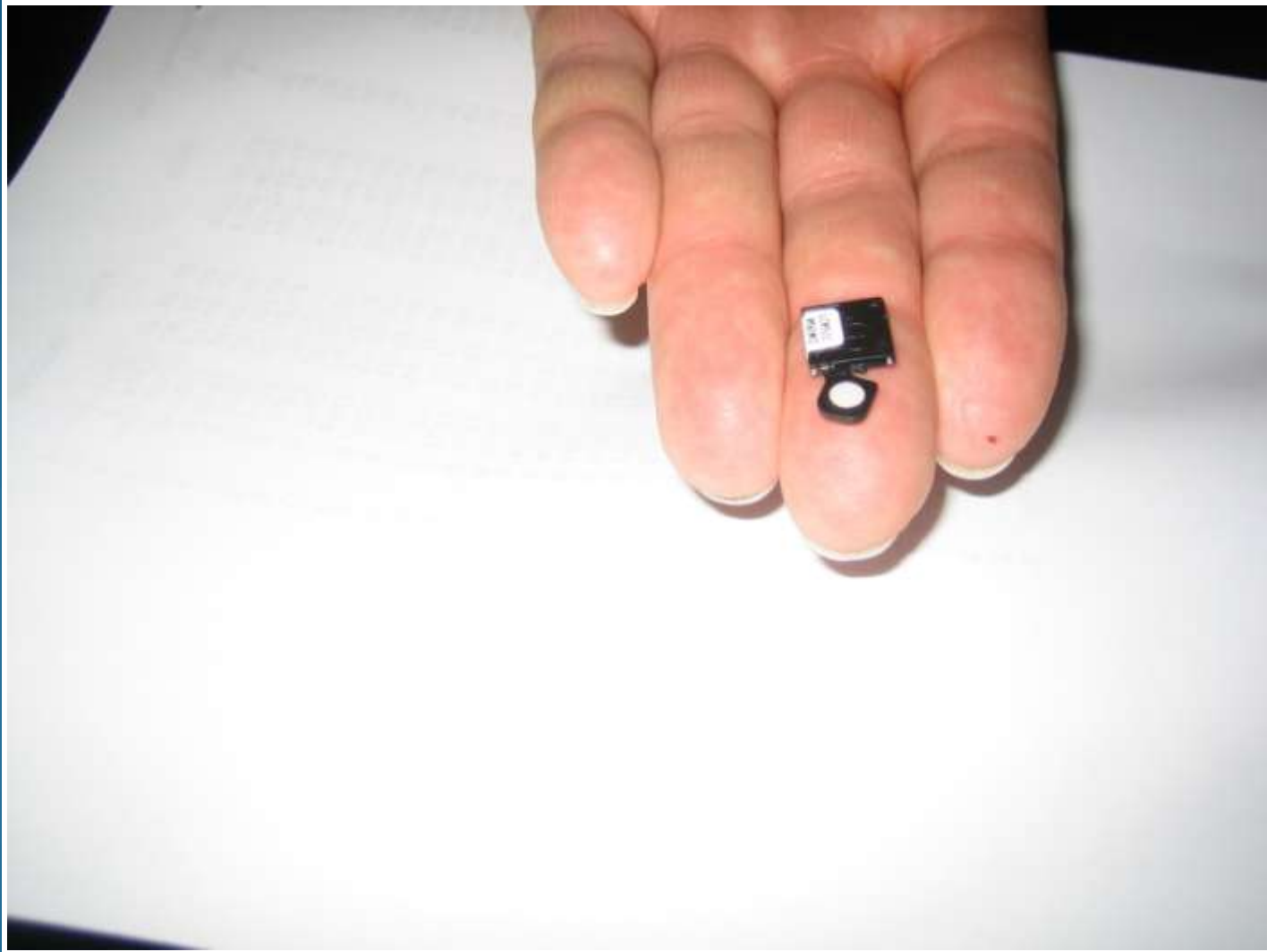
* Custom Calibration (Price per set)

Special Services Dept (708) 441-6441
Email: SpecialServices@landauer.com

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- ✓ In light nanoDot dosimeters-
newest innovation for single point
radiation measurements.
- ✓ nanoDot dosimeters (Al₂O₃)
optically stimulated luminescence
technology (OSL).
- ✓ OSL nanodots are currently being
used for a variety of diagnostic
radiological, therapeutic, and
experimental purposes.
- ✓ OSL nanoDots can be used for a
broad range of ionizing radiation
exposure intensities and qualities.
- ✓ OSL nanoDots are cost effective,
providing accurate, sensitive, and
reliable dose estimates. (Landauer
Inc is AALA accredited facility)

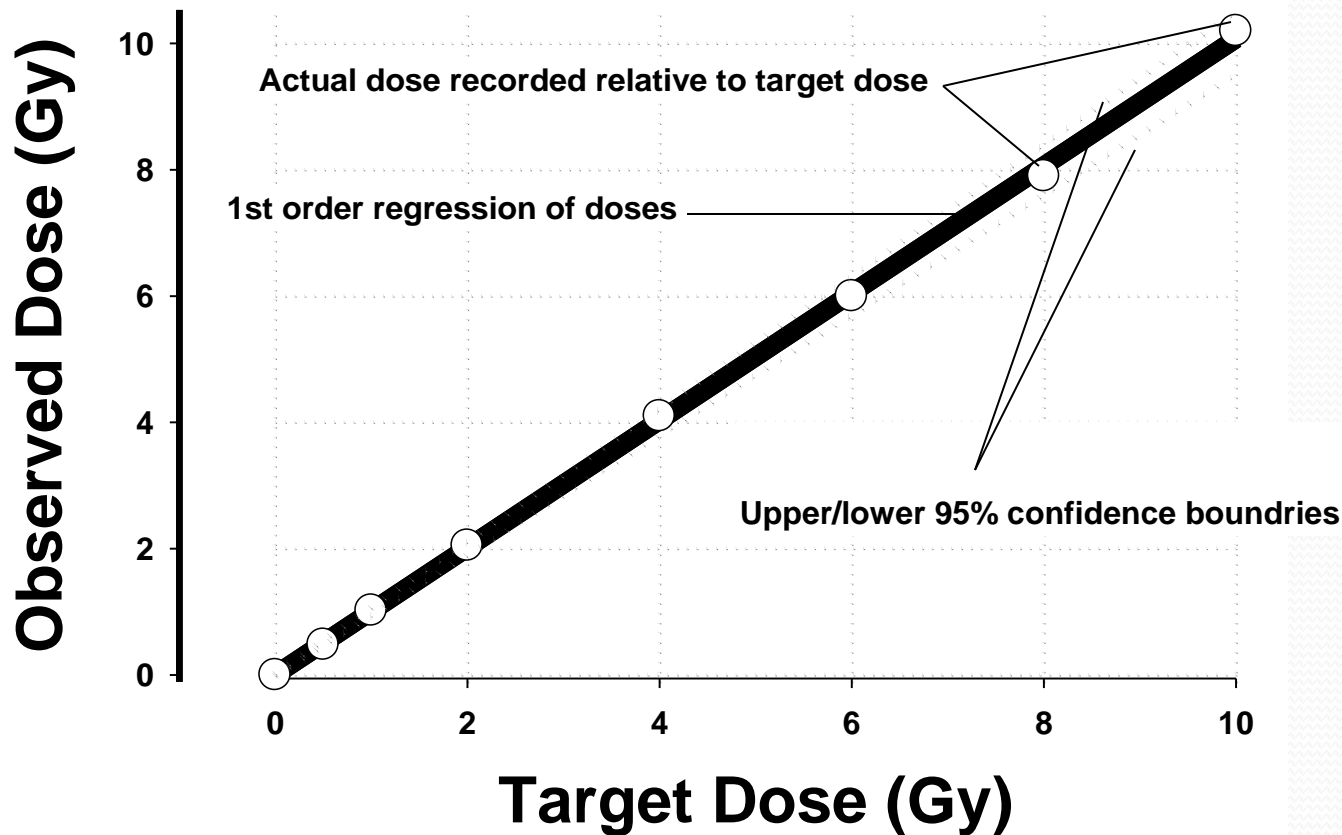
Landauer's In light-nanoDot dosimeters



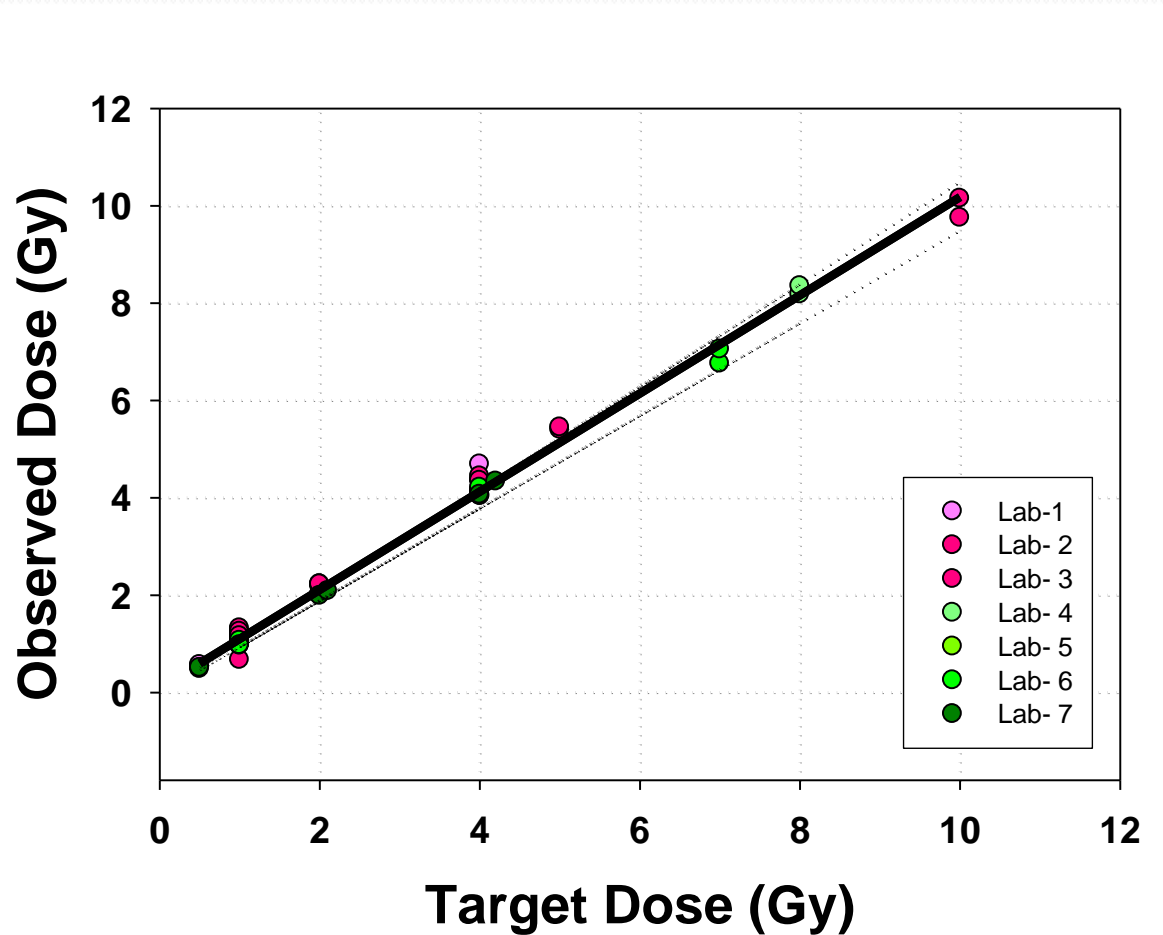
Exposure reader- OSL nanoDots



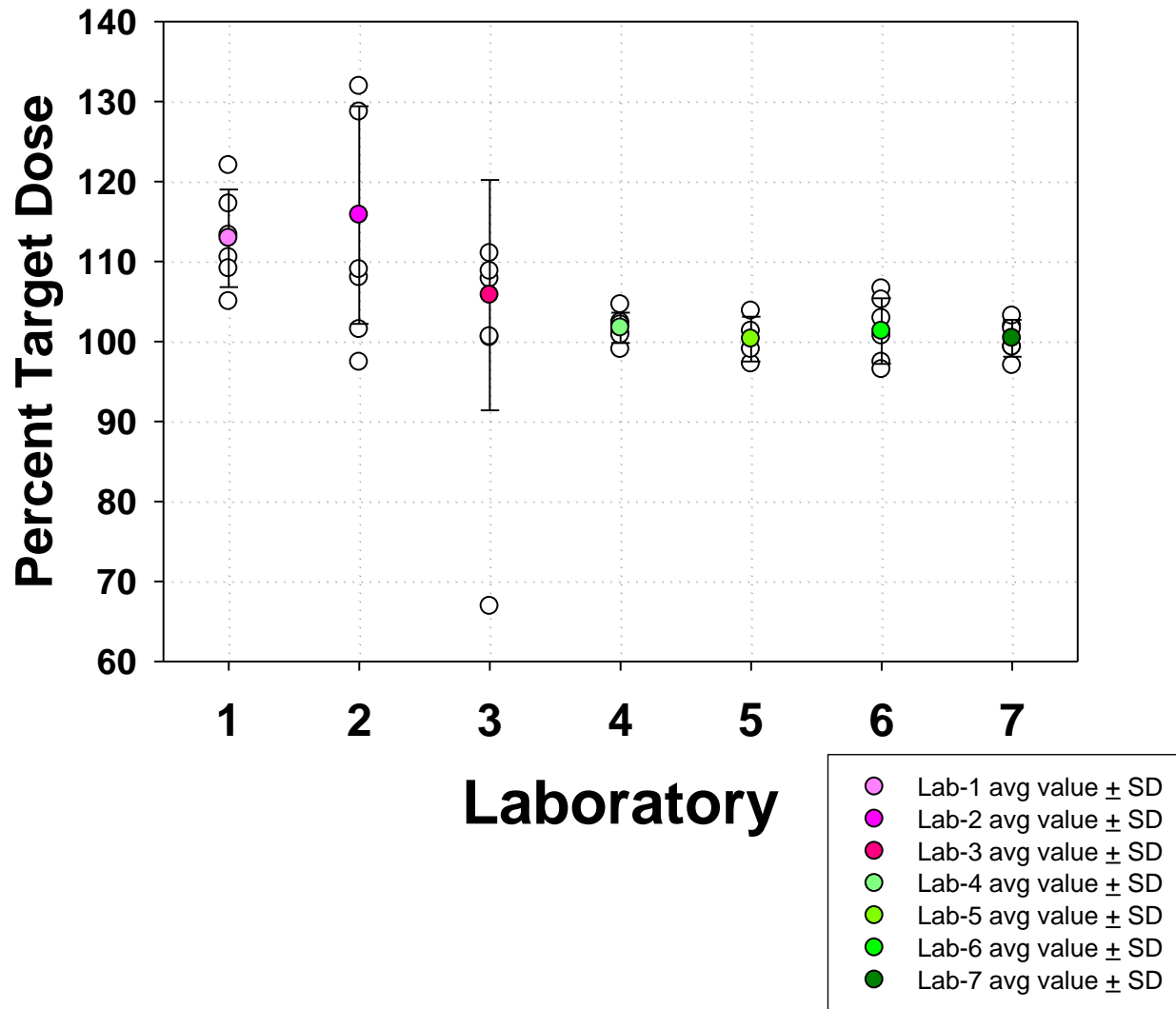
Goal: Maximum error of $\leq 5\%$ for specific doses over a given range of exposures



Results



Results



Results

Lab #	Rad type	Survey	Testing-initiated	Testing-completed	Est dose <5% error	Comment
1	X-ray	Yes	Yes	No	No	Retesting required
2	X-ray	Yes	Yes	No	No	Retesting required
3	X-ray	Yes	Yes	No	No	Retesting required
4	137Cs	Yes	Yes	Yes	Yes	Passed test
5	137Cs	Yes	Yes	Yes	Yes	Passed test
6	137Cs	Yes	Yes	Yes	Yes	Passed test
7	60Co	Yes	yes	Yes	Yes	Passed test

~57% (4/7) labs passed

Summary

- ✓ A review of exposure protocols has been initiated, along with a 'dosimetry exercise' that employs the use of OSL dosimetry technology.
- ✓ All seven labs doing animal-based studies are participating; 7/7 labs have completed an initial survey of planned exposures; All labs have begun the 'dosimeter exercise'; and 4 of 7 labs have successfully completed the exercise.
- ✓ It is anticipated that all participating labs will have completed the 'dosimetry exercise' and will be compliant by this calendar year, 2011.

Acknowledgment

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